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Industrial Mineral Report 41

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# MINERAL FILLERS

By
D. F. HEWITT

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D. F. HEWITT

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# MINERAL FILLERS

By

D.F. Hewitt[1]

## INTRODUCTION

Large tonnages of fine-grained, inert industrial minerals are widely used as mineral fillers in many industries, particularly the paint, paper, rubber goods, pesticide, roofing, and plastics industries. Minerals commonly used include asbestos, barite, bentonite, calcium carbonate, clay, diatomite, mica, nepheline syenite, silica, talc, tremolite, and wollastonite. Most mineral fillers are dry ground and air classified, but where a finer grain size is required wet grinding is sometimes employed. In addition to the ground mineral fillers, a group of fillers are manufactured by chemical precipitation. These include calcium carbonate, blanc fixe, calcium sulphite, and amorphous silica. Manufactured fillers also include carbon black.

In the paint industry, mineral fillers are also known sometimes as mineral pigments or extender pigments, depending on their function in the paint.

As a general rule, natural mineral fillers are most readily obtainable over 1 micron in size, whereas chemically manufactured fillers are available below 1 micron in size.

Whether one mineral filler or another is used may depend on several factors, such as cost per ton, grain size, colour, chemical inertness, opacifying power, refractive index, abrasiveness, specific gravity, and particle shape. One mineral filler may be replaced by another if all requirements for specifications are filled and generally the mineral fillers are manufactured with tailored-to-measure specifications for a particular consumer. Bulk fillers range in price from $3 per ton for limestone dust to about 5 cents per pound for some grades of mica. Specialty fillers command prices of over 5 cents per pound.

## PROPERTIES OF FILLERS

The evaluation of a filler for any particular use depends upon its properties and functions in the use to which it is put. A great variety of grades for a single industrial mineral filler, such as talc or calcium carbonate, is available, and the failure of a particular talc filler, for example, does not rule out the possibility of other grades or varieties of talc being suitable for a particular purpose. One filler supplier, for example, is able to supply as many as 129 different grades of talc, all of which are different in some respect (Mountsier and Gitter 1958, p.1).

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[1]Chief, Phanerozoic Geology Section, Geological Branch, Ontario Division of Mines. Manuscript approved for publication 19 February 1973.

## Colour and Reflectance

When used as a filler for rubber goods or as a carrier for pesticides, very often the colour of the filler may not be a primary concern. However, where the filler is used as an extender pigment in white paint or a filler in paper, a good white colour is essential. Whiteness or brightness is measured spectrophotometrically by comparison with a known standard magnesium oxide of brightness of 100. The best quality white pigment is titanium dioxide, followed by antimony trioxide, and tin oxide. Among the non-metallic mineral fillers with good whiteness are calcium carbonate, some talcs, some barite, nepheline syenite, and wollastonite.

## Refractive Index and Opacity

A mineral filler with a high refractive index will have better opacifying and brightening power than a filler with low refractive index. The optimum particle size of a filler to give the best opacity should be in the range of one-half the wave length of visible light. In general, for paper fillers the material used should have a refractive index of more than 1.53.

The covering or hiding power of a mineral filler depends to a large extent on its opacity.

## Specific Gravity

The specific gravity of mineral fillers varies greatly from 2.02 for diatomite to 5.9 for antimony trioxide. Other specific gravities are: asbestos, 2.4; barite, 4.43; calcium carbonate, 2.71; kaolin, 2.6; mica, 2.8; silica, 2.65; and talc, 2.69. Barite, which is used as a heavy mineral filler for drilling mud, has a specific gravity among the highest of the non-metallic minerals at 4.43. A high specific gravity may be unfavourable in a paper filler where there is the problem of retention in the fibrous cellulose mat.

The apparent density of a filler may vary considerably from the specific gravity due to the particle shape, size, and degree of packing. Figures may be given for loose bulk (volume in cc of 20 grams) and tapped bulk (volume in cc of 20 grams tapped 500 times).

## Chemical Composition and Inertness

Another property, which is of concern in a mineral filler, is its chemical composition and inertness. Most of the silicas and silicate minerals are insoluble in water. Calcium carbonates are attacked by acids and alum. Barite is somewhat soluble in water. For normal use inertness in the medium in which the filler is used is a prerequisite.

## pH

A property of some significance is the pH of a slurry of mineral filler in water. Mountsier and Gitter (1958, p.4) stated that clay, when in an

alkaline system, will be deflocculated and become viscous. Excessive alkali can make it overdeflocculate and turn watery. A slight acid condition will flocculate clay.

## Oil Absorption

The property of absorption is important in mineral fillers especially in the paint, paper, and plastics industries. In the paint industry, the oil absorption value of a filler means the amount of oil required to work a given weight of filler into a paste. The standard rub-out absorption test used in the paint industry involves placing a weighed sample of filler on a lithographic stone and adding oil drop by drop, thoroughly mixing the oil with a stiff spatula. The end point is reached when sufficient oil is added to make a putty-like paste that will form a spiral roll when the paste is lifted from the stone by the spatula. The oil absorption is stated in cubic centimetres of raw linseed oil per 100 grams of filler. Some oil absorption figures for common fillers are as follows: asbestos, 43; barite, 10.8; clay, 28-35; calcium carbonate, 14-16; kaolin, 45; diatomite, 81-90; fullers earth, 30; talc, 22-50.

In general the finer the grind, the higher the oil absorption. Porous fillers like diatomite have high absorption.

## Particle Size and Shape

The grain size of pulverized fillers ranges from 99 percent through 200 mesh to 99 percent through 325 mesh to under 20 microns in size. The lower limit is usually in the 2 to 5 micron range. Precipitated fillers are available below 1 micron in size. Particle shape is also significant in the behaviour of fillers; some fillers like asbestos are fibrous, some like tremolite are acicular, others are equidimensional. Calcium carbonate is characteristically rhombic.

## Abrasiveness

Some filler users are concerned about hard particles or grit in the filler and the degree of abrasiveness is a significant factor in evaluating the filler. For filling paper, high abrasiveness is undesirable due to potential wear on the paper machines. The Valley Iron Tester is used for evaluation of paper fillers (Cummins 1960, p.574).

## Dispersion

Mountsier and Gitter (1958, p.2) stated that the ability of the various inorganic fillers to disperse is related to surface tension of the material but factors such as fineness of grind and method of incorporation of the material will also affect dispersion; wettability also affects dispersion.

## USES OF MINERAL FILLERS

Mineral fillers are used in paint, paper, rubber goods, bituminous compounds, insecticides, roofing, plastics, and other commodities. Brief discussions of the use of mineral fillers in these applications follow.

### Paint

A mineral filler or extender pigment is added to paint to add bulk or to modify the physical properties of the paint. Factors such as film thickness, flow, levelling, settling, porosity, dispersion, viscosity, sheen, colour development, and uniformity may be affected by the choice of the mineral filler (Weitz 1970, p.600). Extender pigments are added to paint for many reasons, such as dilution of the prime pigment in manufacture of inexpensive paints, facilitating suspension, increasing resistance to moisture, strengthening paint film, imparting a characteristic finish to flat paints, to improve sanding properties, to increase the density of the film, to aid working with a brush, to assist primers in filling pores, and enhancing wearing properties of the paint (Harness 1943, p.3).

Weitz (1970, p.600) gave the following formula for a standard, oil-based, flat white wall paint:

| | |
|---|---|
| Binder (e.g. linseed oil) | 22.6% |
| Prime pigment (e.g. titanium dioxide) | 17.9% |
| Extender pigment (e.g. calcium carbonate) | 37.2% |
| Thinner (mineral spirits) | 19.8% |
| Additives (driers, thickeners) | 2.5% |
| Total | 100.0% |

Weitz (1970, p.601) also stated that:

> "...if this paint were to be manufactured without the extender pigment content, the weight per gallon would be extremely high, about 30 pounds per gallon. Also it would be difficult to stir, because the titanium dioxide pigment would have settled to the bottom in a hard cake. The raw material cost per gallon would be very high and the spreading properties would be atrocious. On application to a vertical wall, the paint would run off because its viscosity would be close to that of water. About the only useful property this paint would have would be high hiding. However, with the presence of 37.2 percent extender pigment, this flat wall paint would possess bulk and have the consistency of thick sour cream. It would almost appear as if the paint has been 'fluffed up' or bulked."

Common extender pigments used in paints include barite, kaolin, calcium carbonate, diatomite, talc, mica, gypsum, nepheline syenite, and silica. Table 1 gives the tonnages and value of extender pigments used by the paint industry in Canada in 1970.

Table 1 1970 Consumption of Extender Pigment in the Canadian Paint Industry (from DBS)

| Extender | Quantity (lb) | Cost $ |
|---|---|---|
| Calcium carbonate (natural) | 42,999,827 | 1,056,000 |
| Calcium carbonate (precipitated) | 6,186,896 | 255,000 |
| Talcs | 17,765,625 | 725,000 |
| Barite | 7,364,821 | 380,000 |
| Diatomite | 1,698,423 | 158,000 |
| Kaolin | 7,378,193 | 387,000 |
| Mica | 1,675,486 | 123,000 |
| Silica | 5,261,062 | 398,000 |
| Other extenders | 6,397,205 | 416,000 |

## Paper

Paper is essentially a thin uniform sheet of finely intermeshed cellulose fibres. Binding agents and mineral fillers are added to form a closer textured surface of superior brightness, opacity, and smoothness. The most common mineral fillers employed are clay (kaolin), calcium carbonate, barite (blanc fixe), talc, and gypsum.

Clay is the most commonly used paper filler. Both air-floated and water-washed clay may be used, but the air-floated clays are usually inferior to the water-washed in percentage of grit, colour, and abrasiveness. The clay content in uncoated papers generally ranges from 8 to 20 percent, whereas coated papers carry a somewhat higher percentage of clay. Kaolin is the common clay used and it should be as white as possible, free of grit, inert, and opaque. Fillers are used in two ways in paper: (1) as filler; and (2) as coating. Kaolin is used for both purposes.

Calcium carbonate is second to clay in tonnage used for filler in the paper industry. It is produced either by grinding the mineral calcite, in the form of marble or limestone, or by chemical precipitation. It has the advantage of being cheap and of good white colour. These fillers are practically insoluble but are alkaline in reaction and are attacked by acids and alum. Sharp edges of the mineral particles make it abrasive. Carbonate filler also has greater opacifying power in paper than clay or talc (Willets et al 1958).

Barite, or chemically precipitated blanc fixe, are very heavy, specific gravity 4.43, and are of limited use in paper due in part to low retention. Talcs vary greatly in mineralogy and texture, but some commercial talcs are used in paper and show good retention, are chemically inert, and have good white colour and brightness.

Table 2 Characteristics of Paper Fillers (after Willets et al 1958, p.3).

| Filler | Chemical Composition | Specific Gravity | Refractive Index | Average Particle Size in Microns | Reflectance |
|---|---|---|---|---|---|
| Barium sulphate: | | | | | |
| Barite | $BaSO_4$ | 4.48 | 1.64 | 2-5 | 95 |
| Blanc fixe | $BaSO_4$ | 4.35 | 1.64 | 0.5-2 | 98 |
| Calcium carbonate: | | | | | |
| Natural ground | $CaCO_3$ | 2.7 | 1.56 | 3-5 | 93 |
| Precipitated | $CaCO_3$ | 2.7-3.0 | 1.56 | 0.2-0.5 | 95 |
| Gypsum | $CaSO_4.2H_2O$ | 2.36 | 1.52 | ... | ... |
| Clay | hydrous Al silicate | 2.5-2.8 | 1.56 | 0.5-1.0 | 70-90 |
| Diatomite | $SiO_2$ | 2.3 | 1.33 | 2-10 | 60-90+ |
| Talc | hydrous Mg silicate | 2.8 | 1.57 | 1-10 | 70-90+ |

## Rubber Goods

Fillers used in rubber include barite, calcium carbonate, diatomite, gypsum, mica, and talc. A suitable mineral filler provides reinforcing, stiffening, and resistance to abrasion.

## Bituminous Compounds

Asphalt sheeting and shingles use large tonnages of mineral fillers, particularly talc, asbestos, calcium carbonate, and silica. Other uses are for flooring, caulking compounds, joint fillers, and waterproof coatings. Fillers tend to increase viscosity and resistance to mechanical stress and weathering, and increase hardness (Cummins 1960, p.576). Lower grades of mica and talc are used for dusting asphalt roll roofing and shingles to prevent sticking.

## Insecticides

Mineral fillers such as clays, talc, calcium carbonate, diatomite, and silica are used as carriers or diluents for insecticides. Absorptive capacity of the filler is generally important.

## Plastics

Pulverized industrial minerals, which are used as reinforced plastic fillers, include asbestos, barite, calcium carbonate, clay, diatomite, mica, and talc. These mineral fillers improve the physical properties of the plastic in various ways, such as imparting strength, increasing abrasion resistance, increasing the bulk of the material, and improving moulding

characteristics. Properties such as particle size, density, bulk, colour, dispersion, pH, thermal behaviour, particle shape, and inertness are important in choosing the correct mineral filler.

## MINERAL FILLERS

The principal mineral fillers used in Canada are asbestos, barite, calcium carbonate, clay, diatomite, gypsum, mica, nepheline syenite, silica, talc, and tremolite, and wollastonite. Most of these are described below.

### Asbestos

Chrysotile asbestos has a composition of $3MgO.2SiO_2.2H_2O$. The colour is usually grey in powdered form. Wettability and suspension in water is good. Ion concentration as pH in slurry is 9.2. Specific gravity is 2.4 to 2.57. Oil absorption (rub-out) is 43. Relative abrasiveness and opacity are fair. The cost averages about 2.3 cents per pound for group 7R shorts.

The shorter grades of asbestos, groups 5, 6, and 7, are used as mineral fillers. Group 5 asbestos is used in asbestos cement products including sheets, pipes, and moulded products. It is also used in some paper products such as pipe wrappings. Group 6 asbestos is used in asbestos cement products, vinyl sheet backings, and millboard. Group 7 asbestos is used in brake lining, clutch facings, and extensively as a filler in vinyl and asphalt floor tile, plastics, and caulking compounds. It is also used as a filler in paint.

Filler grades of asbestos are produced in Ontario from the Reeves Mine of Canadian Johns-Manville Company Limited and by Hedman Mines Limited.

### Barite

Barite has a composition of $BaSO_4$. In the fairly pulverized form it is used as a mineral filler. The chemically precipitated form of $BaSO_4$, known as blanc fixe, is also used as a filler. The white-coloured varieties of barite are preferred and barite having a reflectance of 94 is available. Ground barite that is discoloured by iron staining may be bleached by sulphuric acid to attain better colour. The ion concentration, as pH in a slurry, is 4 to 5. Barite is characterized by a very high specific gravity of 4.4. Oil absorption (rub-out) is 5 to 11, which is low. It decomposes at 1,580°C. The cost of a good grade white barite filler is less than 3 cents per pound. Blanc fixe is finer in grain size and is more expensive.

Ground barite is used as an extender pigment in oil- and water-based paints and particularly for metal primers. Its low oil absorption is an advantage but its low index of refraction results in low hiding power. It is also used as a filler in oil cloth, linoleum, plastics, and rubber goods. Its use in paper is limited due to poor retention.

Barite for filler is not mined at present in Ontario.

The ASTM standard specification for dry barium sulphate pigments (D602-42) is as follows:

| | Barite | Blanc Fixe |
|---|---|---|
| Barium sulphate, minimum percent | 94.0 | 97.0 |
| Ferric oxide, maximum percent | 0.005 | 0.002 |
| pH, minimum | 3.5 | 3.5 |
| Matter soluble in water, percent | 0.2 | 0.2 |
| Moisture and other volatile material, maximum percent | 0.5 | 0.5 |
| Coarse particles, total residue, retained on 325 mesh sieve, maximum percent | 0.5 | 0.5 |
| Free silica (quartz, clays, etc.), maximum percent | 2.0 | 2.0 |

## Calcium Carbonate

Calcium carbonate, with the chemical formula $CaCO_3$, occurs in a variety of forms in nature. As a filler the calcium carbonate will have one of the following forms: (1) ground limestone, (2) ground marble, (3) marl, (4) chalk, (5) whiting or artificial whiting, and (6) precipitated calcium carbonate.

In some cases, ground dolomite or ground dolomitic marble composed of $(Ca,Mg)CO_3$ is also used. Where a good white colour is essential, the preferred material is ground marble, chalk, whiting, or precipitated calcium carbonate. Ground limestone is likely to be off colour, but is desirable for its cheapness for uses where colour is not of paramount importance. Calcium carbonates with reflectance of over 95 are available in particle size down to 1 micron. Precipitated calcium carbonate may have a mean particle size down to 0.25 microns. Wettability and suspension in water are generally good. The ion concentration, as pH in slurry, is 9.2 to 9.5. This filler will react with acids and alum. Oil absorption is low ranging from 5 to 16. It decomposes at 825°C giving off carbon dioxide and turning into lime. Specific gravity is 2.71. Index of refraction is 1.59. Costs range from 4 to 5 dollars per ton for pulverized limestone to 2 cents per pound for pulverized marble.

Important properties of filler grade calcium carbonate include colour, fineness, freedom from grit, low oil absorption, and particle shape. The rhombic character of calcite particles sometimes yields a rather abrasive particle. Whiting or calcium carbonate is used in glazes and enamels where a high calcium material is desirable. Calcium carbonate is used as an extender pigment in paint where chalk whiting is preferred due to its opacity. For use in rubber goods, a fine particle size is desirable; it should be easily dispersible and have good bonding properties with the rubber. Putty is made from whiting or calcium carbonate and linseed oil; properties of fineness, freedom from grit, and low oil absorption are desirable. Calcium carbonate is used frequently as a filler in paper due to its brightness, opacifying qualities, and susceptibility to printers ink. Calcium carbonate is also used in the manufacture of linoleum, oilcloth, explosives, cleaning and polishing compounds, cosmetics, insecticides, plastics, and roofing cements. For asphalt filler, colour is not important and this market is largely supplied by limestone dust.

Table 3 Canadian Consumption of Whiting (DBS)

(Ground chalk, whiting, and whiting substitute)

| | 1965 tons | 1966 tons |
|---|---|---|
| Paints and varnish | 18,519 | 16,618 |
| Linoleum, oilcloth, floor tile | 24,879 | 30,627 |
| Rubber goods | 23,673 | 20,801 |
| Asbestos products | 6,888 | 10,374 |
| Paper | 4,722 | 33,057 |
| Gypsum products | 3,845 | 11,357 |
| Roofing | 5,858 | 15,780 |
| Sugar processing | 10,198 | ... |
| Foundry | 2,617 | 3,035 |
| Fertilizer and poultry feed | 1,811 | 1,299 |
| Miscellaneous chemicals | 1,485 | 738 |
| Other uses | 9,056 | 8,779 |
| Total | 113,551 | 152,465 |

Limestone filler is produced in Ontario by several quarries, particularly in the Beachville area. The marble whiting industry in Ontario has good potential, but production at present is small.

## Clay

Clays are among the most common mineral fillers and kaolin is the usual type of clay employed in filler uses. Kaolin is a hydrous aluminum silicate having a composition of $Al_2O_3.2SiO_2.2H_2O$. The desirable colour is white and reflectance may reach 85 to 90. Extremely fine grain size may be obtainable through beneficiation. Wettability and suspension in water are good. The ion concentration, as pH in slurry, is from 4.5 to 8. Relative abrasiveness is low and opacity is good. Specific gravity is 2.5 to 2.6. Costs run from 1 to 5 cents per pound. Particle size may range from 0.2 to 10 microns. Clays are generally chemically inert but do have sorptive properties.

The two basic types of filler clay are air-floated and water washed. One of the largest uses of clay filler is in the paper industry where the clay content of coated papers may reach 30 percent. Colour, abrasiveness, opacity, and dispersion qualities are important.

Clay is used in rubber goods to reinforce and stiffen the product. Hard clays give rubber a resistance to abrasion. Clays are also used as a carrier or diluent in pesticides where such qualities as good sorptive properties, low abrasion, and compatibility with chemicals are important. Clays are used to some extent as extenders in paint due to its low specific gravity and high dispersion, but its high oil absorption (up to 50) is a disadvantage.

No filler grade clays are presently produced in Ontario.

## Diatomite

Diatomite is composed of the siliceous skeletons of diatoms, an aquatic plant. It is composed of $SiO_2$ and is characterized by its cellular character and light weight. Diatomite is usually whitish or cream coloured; brown varieties become white on calcining. Its specific gravity is 2, but due to its porous character it will float on water. The apparent density of loose powdered diatomite is 8 to 16 pounds per cubic foot. Its abrasiveness is high and its opacity is low. Oil absorption (rub-out) is high ranging from 80 to 90. Price ranges from 2 to 7 cents per pound.

Diatomite is a useful filler where bulk is needed with minimum weight. It is used in paint, asphalt products, paper, and plastics. Being made of silica, it has the advantage of being chemically inert.

Although several small diatomite deposits are known in Ontario, there is no present production.

## Gypsum

Gypsum has the formula $CaSO_4.2H_2O$. The filler grade of pulverized gypsum is white in colour and some grades have a reflectance of over 90. Oil absorption is 20 to 25. On heating, three-quarters of the water is driven off at a low temperature (about 320°F) to form $CaSO_4.\frac{1}{2}H_2O$. Specific gravity is 2.3.

Gypsum is not widely used as filler but some is used as a filler in paint, textiles, and paper.

Gypsum is mined in Ontario but no filler grade material is produced.

## Mica

Phlogopite, muscovite, and sericite micas are all used as fillers. Scrap mica can be dry ground to produce a filler grade material in the range of 5 to 20 microns. Micronized mica is produced by dry grinding in a 'Micronizer'. Filler grade mica is also produced by wet grinding. This process preserves the sheen on the mica flakes. In chemical composition, muscovite is a hydrous potassium aluminium silicate, whereas phlogopite is a hydrous potassium magnesium aluminium silicate sometimes containing iron. The specific gravity is 2.6 to 3.2. Muscovite is inert and generally unaffected by acids. Oil absorption ranges from 25 to 70.

Ground mica is used in making rolled roofing and asphalt shingles, both as an inert filler and as a surface coating to prevent sticking of adjacent surfaces. Ground mica is used in paint as an extender due to its good suspension properties. It reduces checking and chalking, and prevents shearing and shrinkage of the paint film. It also increases the paint's resistance to weather. The rubber industry uses ground mica as a mold lubricant and surfacing for rubber goods and tires. Mica is also used as a filler in plastics. Mica finds limited use in paper, but is used for surfacing some varieties of wallpaper.

No filler grade mica is presently produced in Ontario.

## Nepheline Syenite

Nepheline syenite is composed of albite, microcline, and nepheline. It is chemically inert. The refractive index is 1.54. The colour is white with reflectance as high as 98. The specific gravity is 2.61. Oil absorption is 22 to 23. Ion concentration as pH is 9. Fine uniform grain size is produced in the range of 4 to 8 microns.

Nepheline syenite is used as an extender pigment in paints; brightness is good and it tends to prevent cracking and chalking. Nepheline syenite exhibits good dispersion properties.

Nepheline syenite of filler grade is produced from mines in Methuen Township, Peterborough County.

## Silica

Ground silica in the form of quartz has the composition $SiO_2$. The colour is white or off white. Wettability is good, but suspension in water is poor. Oil absorption ranges from 19 to 30. The particles are hard and abrasive. Specific gravity is 2.66. Refractive index is 1.55. An amorphous variety of silica is produced by a high temperature vapour phase chemical reaction. This amorphous silica is also used as a filler.

Amorphous silica is used to reduce caking and resistance to flow. It is also used to thicken liquids. It finds wide use in insecticides, greases, paint, pharmaceuticals, paper, textiles, and rubber goods.

Some filler grade silica is produced from the quartzite from the Killarney quarry at Badgeley Island.

## Talc

The mineral talc is a hydrous magnesium silicate having the theoretical formula $H_2Mg_3(SiO_3)_4$. Commercial grades of filler talc usually contain variable amounts of tremolite and calcium carbonate. Talc has a hardness of 1 to 1.5 and a specific gravity of 2.7 to 2.8. It has perfect basal cleavage and greasy lustre. It grinds to a white colour and the reflectance may exceed 96 in the whiter grades. Wettability is poor to good and suspension in water is good. Oil absorption ranges from 22 to 50. It should be emphasized that due to the great mineralogical range of materials being marketed as talc, there is a considerable variation in properties of these materials.

Among the important properties of talc are its extreme whiteness, smoothness, softness, and slip, and its flaky or fibrous shape depending on percentage of talc and tremolite present. It has a large surface area compared to its density; good covering power in paint; chemical inertness; low electrical and thermal conductivity; and a high fusion point.

White talc of high quality is used as an extender in paints. A low content of carbonates and grit is desirable. Important factors are oil absorption and particle size and shape. Lower grades of talc are used in the roofing industry as an inert, fireproof, weather-resistant coating for tar-paper, roll roofing, and asphalt shingles. Talc is also used as a filler for paper. Colour or brightness, particle size and shape, smoothness, percent grit, weight, and printability are factors for evaluation of the filler. The good retention, white colour, high reflectance, and inertness of talc makes it particularly suitable as paper filler. Talc is used in the rubber industry for dusting, lubricating molds, and coating rubber surfaces to prevent sticking. Talc is also used as a carrier for insecticides.

Figures for consumption of ground talc and soapstone, in Canada in 1969 and 1970, as given by the Dominion Bureau of Statistics, are as follows:

| Uses | 1969<br>tons | 1970<br>tons |
|---|---|---|
| Rubber products | 1,925 | 1,502 |
| Asphalt roofing | 9,051 | 8,127 |
| Batteries | 41 | 46 |
| Electrical products | ... | 97 |
| Clay products | 3,613 | 7,632 |
| Pharmaceuticals and medicines | 406 | 672 |
| Paint and varnish | 8,883 | 9,410 |
| Soap and cleaning compounds | 109 | 82 |
| Toilet preparations | 1,147 | 971 |
| Miscellaneous chemical industries | 2,707 | 2,118 |
| Miscellaneous petroleum and coal products | 1,056 | 464 |
| Total | 28,939 | 31,121 |

Filler grade talc is produced at Madoc by Canada Talc Industries Limited.

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